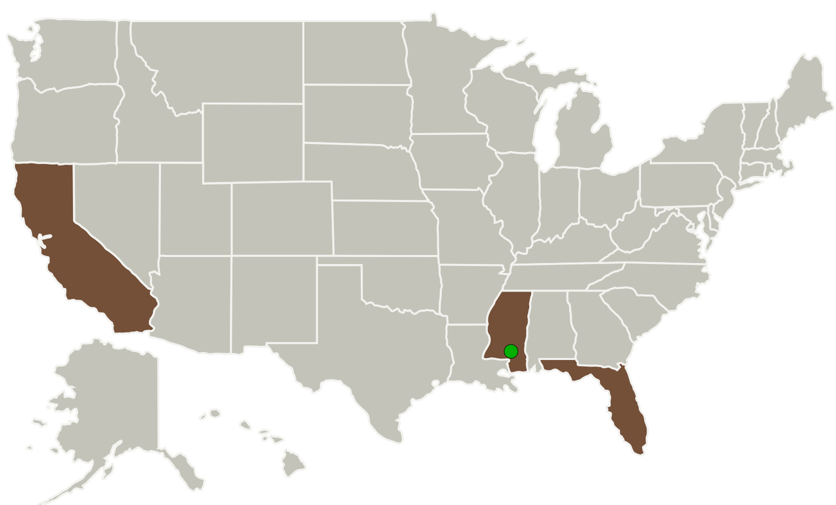
High Performance Simulation Tool for Multiphysics Propulsion Using Fidelity-Adaptive Combustion Modeling, Phase I

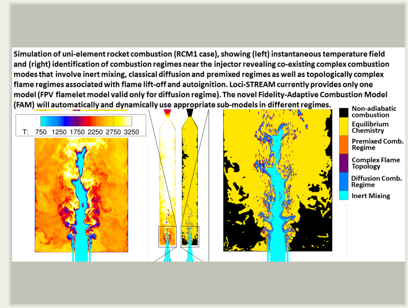
Completed Technology Project (2017 - 2018)

Project Introduction

The innovation proposed here is a fidelity-adaptive combustion model (FAM) implemented into the Loci-STREAM CFD code for use at NASA for simulation of rocket combustion. This work will result in a high-fidelity, high-performance multiphysics simulation capability to enhance NASA's current simulation capability of unsteady turbulent reacting flows involving cryogenic propellants. This novel FAM model utilizes a combustion submodel assignment, combining flamelet-based combustion models (such as inert-mixing models, equilibrium chemistry, diffusion-flame Flamelet/Progress Variable (FPV) or premixed-flame models) for the computationally efficient characterization of quasi one-dimensional, steady, and equilibrated combustion regimes, with combustion models of higher physical fidelity (such as thickened flame models, reduced/lumped chemistry models) for accurate representation of topologically complex combustion regions (associated with flame-anchoring, autoignition, flame-liftoff, thermoacoustic coupling, and non-equilibrium combustion processes) that are not adequately represented by the current flamelet model in Loci-STREAM. In FAM, the selection of a combustion submodel from a set of models available to a CFD-combustion solver is based on user-specific information about quantities of interest and a local error control. With this information, FAM performs an identification procedure for an optimal combustion submodel assignment from the available combustion models that. This simulation capability will have direct impact on NASA's ability to assess combustion instability of rocket engines.

Primary U.S. Work Locations and Key Partners





High Performance Simulation Tool for Multiphysics Propulsion Using Fidelity-Adaptive Combustion Modeling, Phase I Briefing Chart Image

Table of Contents

Project Introduction	1
Primary U.S. Work Locations and Key Partners	1
Project Transitions	2
Organizational Responsibility	2
Project Management	2
Technology Maturity (TRL)	2
Images	3
Technology Areas	3
Target Destinations	3

Organizations Performing Work	Role	Type	Location
Streamline Numerics, Inc.	Lead Organization	Industry	Gainesville, Florida
Stanford University(Stanford)	Supporting Organization	Academia	Stanford, California
Stennis Space Center(SSC)	Supporting Organization	NASA Center	Stennis Space Center, Mississippi

Primary U.S. Work Locations	
California	Florida
Mississippi	

Project Transitions

June 2017: Project Start

June 2018: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/140837)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Streamline Numerics, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

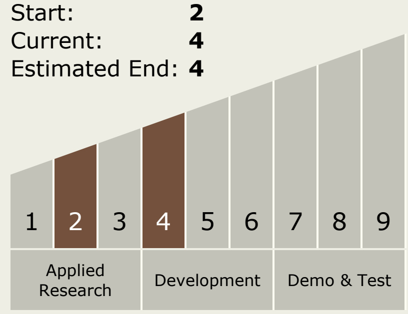
Carlos Torrez

Principal Investigator:

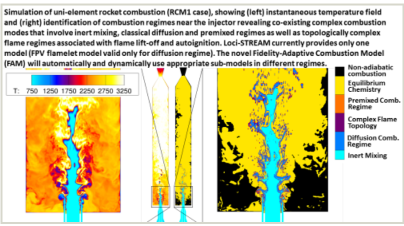
Siddharth S Thakur

Technology Maturity (TRL)

Start: **2**
Current: **4**
Estimated End: **4**



Images



Briefing Chart Image
High Performance Simulation Tool for Multiphysics Propulsion Using Fidelity-Adaptive Combustion Modeling, Phase I Briefing Chart Image
(https://techport.nasa.gov/image/130741)

Technology Areas

Primary:

- TX01 Propulsion Systems
  └ TX01.1 Chemical Space Propulsion
    └ TX01.1.3 Cryogenic

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System